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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

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June 1970

U.S. Training and
Employment Service
Technical Report
S-413 R

Development of USTES

APTITUDE TEST
BATTERY FOR

REFRIGERATION-AND-HEATING MECHANIC

(any ind.)
637.251

U.S. DEPARTMENT OF LABOR
Manpower Administration

FL 002 025

ED 068544

Technical Report on Development of USTES Aptitude Test Battery

For . . . .

Refrigeration and Heating Mechanic (any ind.) 637.251-010

S-413R

(Developed in Cooperation with the
Michigan State Employment Service)

U.S. Department of Labor
Manpower Administration

June 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study #2693

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

for

Refrigeration and Heating Mechanic (any ind.) 637.251-010

S-413R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Refrigeration and Heating Mechanic (any ind.) 637.251-010. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	100
Q - Clerical Perception	95
M - Manual Dexterity	85

RESEARCH SUMMARY

Sample:

66 male Refrigeration, Heating, & Air Conditioning students at Ferris State College, Big Rapids, Michigan. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion:

Core curriculum grade-point average earned in six-quarter Refrigeration, Heating, & Air Conditioning curriculum.

Design:

Concurrent (test and criterion data were colleced at approximately the same time)

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations,

aptitude criterion correlations and selective efficiencies.

Concurrent Validity:

Phi coefficient = .35 ($P/2 < .005$)

Effectiveness of Norms:

Only 70% of the nontest-selected students used for this study were good students; if the students had been test-selected with the S-413R norms, 81% would have been good students. 30% of the nontest-selected students used for this study were poor students; if the students had been test-selected with the S-413R norms, only 19% would have been poor students. The effectiveness of the norms is shown graphically in Table I:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Students	70%	81%
Poor Students	30%	19%

SAMPLE DESCRIPTION

Size: N = 66

Occupational Status: Students who completed the six-quarter curriculum in Refrigeration, Heating, & Air Conditioning.

Educational Institution: Students were enrolled in the Trade and Industrial Division, Ferris State College, Big Rapids, Michigan.

Course Selection Requirements:

Education: High school education or equivalent or sufficient maturity, motivation and aptitude to profit from instruction.

Previous Experience: None required.

Tests: None used

Other: Application for admission into the curriculum and a personal conference if needed to ascertain applicant's fitness for success.

Principal Activities:

The job duties of the occupation and the subjects contained in the course of study are shown in the Appendix.

Minimum Experience:

All students in the sample had been enrolled in the curriculum for at least 5 quarters.

TABLE 2

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age & Education.

	Mean	SD	Range	r
Age (years)	22.0	2.5	18-31	.229
Education (years)	14.1	.4	14-16	.048

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B, were administered during the period November 1963 to March 1967.

CRITERION

The criterion data consisted of core curriculum grade-point averages earned in the six-quarter Refrigeration, Heating, & Air Conditioning course. Grade-point averages were computed as follows: total number of honor points (A-4, B-3, C-2, D-1, E-0) received divided by course hours taken, and multiplied by 100.

Criterion Distribution:

Possible Range:	0-400
Actual Range:	200-397
Mean:	309.4
Standard Deviation:	52.1

Criterion Dichotomy:

The criterion distribution was dichotomized into high and low groups by placing 30% of the sample in the low criterion group to correspond with the percentage of students considered unsatisfactory or marginal. Students in the high criterion group were designated as "good students" and those in the low group as "poor students". The criterion critical score is 270.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORM

Aptitudes were considered for tryout in the norms on the basis of a qualitative analysis of the job and course duties involved and a statistical analysis of test and criterion data. Aptitudes S and M which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated they were important in the job and course duties and the sample had a relatively high mean score on these aptitudes. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis

(Based on the analysis of the job and course duties, the aptitudes listed appear to be important for course success.)

Aptitude	Rationale
G - General Learning Ability	Necessary to complete technical course material; to analyze building properties; to determine space and type of equipment to be used.
V - Verbal Aptitude	Necessary in selling; following written directions; in studying basic theories.
S - Spatial Aptitude	Necessary for reading blueprints; analyzing building properties; determining space, size and type of equipment; assembly of structural and functional components.
F - Finger Dexterity	Necessary in assembling, dismantling, repairing system components; in starting and adjusting equipment.
M - Manual Dexterity	Necessary for using tools in installation of system components; for dismantling and repair.

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 66

Aptitude	Mean	SD	Range	r
G-General Learning Ability	112.3	12.4	84-139	.526**
V - Verbal Aptitude	100.6	10.7	78-123	.459**
N - Numerical Aptitude	110.4	12.6	80-140	.508*
S - Spatial Aptitude	122.7	16.8	74-160	.148
P - Form Perception	114.5	15.3	81-148	.191
Q - Clerical Perception	111.6	12.8	82-146	.375**
K - Motor Coordination	106.2	17.3	72-177	.226
F - Finger Dexterity	104.1	17.9	63-144	.039
M - Manual Dexterity	115.0	17.7	76-154	.117

**Significant at the .01 level

TABLE 5
Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X	X		X				X	X
Irrelevant									
Relatively High Mean				X	X				X
Relatively Low Standard Dev.	X	X	X			X			
Significant Correlation with Criterion	X	X	X			X			
Aptitudes to be Considered for Trial Norms	G	V	N	S		Q			M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of Aptitudes G, V, N, S, Q, and M at trial cutting scores were able to differentiate between the 70% of the sample considered good students and the 30% of the sample considered poor students. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores slightly less than one standard deviation below the mean will eliminate about one-third of the sample. The phi coefficient was used as a basis for comparing trial norms. The optimum differentiation for the occupation of Refrigeration and Heating Mechanic (any ind.) 637.251-100 was provided by

norms of N-100, Q-95, and M-85. The validity of these norms is shown in Table 6 and is indicated by a phi coefficient of .35 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms, N-100, Q-95 and M-85

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	8	38	46
Poor Students	11	9	20

Phi coefficient (ϕ) = .35 Chi square (X^2_Y) = 7.9
Significant level = $P/2 < .005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-15 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. A phi coefficient of .34 is obtained with the OAP-15 norms of G-95, S-95 and M-85.

A-P-P-E-N-D-I-X

Non-Core Curriculum Required Courses:

Continuing Orientation - 1 hour/week (1st quarter)

Basic Mathematics - 5 hours/week (1st quarter)

Communications - 3 hours/week (1st, 2nd and 3rd quarter)

Health & Physical Education - 3 hours/week (1st, 2nd and 3rd quarter)

Technical Mathematics (algebra) - 5 hours/week (2nd quarter)

Everyday Law - 4 hours/week (2nd quarter)

Technical Mathematics (Slide Rule) - 2 hours/week (3rd quarter)

Technical Drafting - 4 hours/week (3rd quarter)

Mechanics and Heat - 7 hours/week (4th quarter)

Sheet Metal Drafting - 4 hours/week (4th quarter)

Political Science - 5 hours/week (5th quarter)

Typing - 5 hours/week (5th quarter)

Technical Report Writing - 3 hours/week (6th quarter)

Man & Society - 5 hours/week (6th quarter)

Core Curriculum Required Courses:

Basic and Domestic Refrigeration - 20 hours/week (2nd quarter)

Commercial Refrigeration - 20 hours/week (3rd quarter)

Sheet Metal - 4 hours/week (4th quarter)

Applied Electricity - 4 hours/week (1st quarter)

Transportation, Refrigeration and Air Conditioning - 4 hours/week (3rd quarter)

Air Conditioning - 20 hours/week (4th quarter)

Heating - 20 hours/week (5th quarter)

Advanced Heating and Air Conditioning Problems - 20 hours/week (6th quarter)

Air Movement and Ventilation - 4 hours/week (5th quarter)

Electrical Circuitry and Controls - 4 hours/week (6th quarter)

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FACT SHEET

Job Title: Refrigeration and Heating Mechanic (any ind.) 637.351-010.

Job Summary:

Sells and installs heating equipment, such as furnaces, boilers, and radiators in commercial, industrial and residential buildings. Analyzes building properties to determine space to be heated and probable heat loss and gain under differing weather conditions. Selects the size and the type of equipment. Uses knowledge of refrigeration, structural layout, and function and design of components to install and repair industrial, commercial and domestic refrigerating and cooling systems according to engineering specifications and blueprints. Assembles structural and functional components, such as pipes, cores, condensers, motors, pumps, controls, switches, gauges and compressors. Starts and observes the operation of the system and adjusts mechanisms to control level of fluid, pressure, and temperature in the system. Dismantles, tests and repairs malfunctioning system components. Adjusts or replaces defective or worn-out parts to repair the system.

Course Summary:

This program is divided into these general areas: Domestic Refrigeration, Commercial Refrigeration, and Air Conditioning, heating and cooling.

The domestic area includes the basic theory of refrigeration and the use of testing equipment, gauges and tools used in servicing. In the shop training is provided on domestic freezers and refrigerators.

Commercial training is done on reach-in and walk-in units found in stores, dairies, and markets. There is theory and trouble shooting of units and use of slide rule in heat load calculations.

Both summer and winter air conditioning is included in this program. This includes the uses of air conditioning, air circulation, temperature and humidity control, air cleaning and delivery. The air conditioning course includes the calculation of heat losses and gains and the layout, planning and design of cooling and heating systems. The heating course includes installation and servicing of oil burners, gas burners, gas fired systems, and the controls needed for these systems.

Effectiveness of Norms:

Only 70% of the nontest-selected students used for this study were good students; if the students had been test-selected with the S-413R norms, 81% would have been good students. 30% of the nontest-selected students used for this study were poor students; if the students had been test-selected with the S-413R norms, only 19% would have been poor students.

Applicability of S-413R Norms:

The aptitude test battery is applicable to jobs which include a majority of the duties described above.

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